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[Intervention Review]

Catheter impregnation, coating or bonding for reducing central venous catheter-related infections in adults

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ABSTRACT

Background

The central venous catheter (CVC) is essential in managing acutely ill patients in hospitals. Bloodstream infection is a major complication in patients with a CVC. Several infection control measures have been developed to reduce bloodstream infections, one of which is impregnation of CVCs with various forms of antimicrobials (either with an antiseptic or with antibiotics). This review was originally published in June 2013 and updated in 2016.

Objectives

Our main objective was to assess the effectiveness of antimicrobial impregnation, coating or bonding on CVCs in reducing clinically-diagnosed sepsis, catheter-related blood stream infection (CRBSI), all-cause mortality, catheter colonization and other catheter-related infections in adult participants who required central venous catheterization, along with their safety and cost effectiveness where data were available. We undertook the following comparisons: 1) catheters with antimicrobial modifications in the form of antimicrobial impregnation, coating or bonding, against catheters without antimicrobial modifications and 2) catheters with one type of antimicrobial impregnation against catheters with another type of antimicrobial impregnation. We planned to analyse the comparison of catheters with any type of antimicrobial impregnation against catheters with other antimicrobial modifications, e.g. antiseptic dressings, hubs, tunnelling, needleless connectors or antiseptic lock solutions, but did not find any relevant studies. Additionally, we planned to conduct subgroup analyses based on the length of catheter use, settings or levels of care (e.g. intensive care unit, standard ward and oncology unit), baseline risks, definition of sepsis, presence or absence of co-interventions and cost-effectiveness in different currencies.

Search methods

We used the standard search strategy of the Cochrane Anaesthesia, Critical and Emergency Care Review Group (ACE). In the updated review, we searched the Cochrane Central Register of Controlled Trials (CENTRAL; 2015, Issue 3), MEDLINE (OVID SP; 1950 to March 2015), EMBASE (1980 to March 2015), CINAHL (1982 to March 2015), and other Internet resources using a combination of keywords and MeSH headings. The original search was run in March 2012.

Selection criteria

We included randomized controlled trials (RCTs) that assessed any type of impregnated catheter against either non-impregnated catheters or catheters with another type of impregnation in adult patients cared for in the hospital setting who required CVCs. We planned to include quasi-RCT and cluster-RCTs, but we identified none. We excluded cross-over studies.

Data collection and analysis

We extracted data using the standard methodological procedures expected by Cochrane. Two authors independently assessed the relevance and risk of bias of the retrieved records. We expressed our results using risk ratio (RR), absolute risk reduction (ARR) and number need to treat to benefit (NNTB) for categorical data and mean difference (MD) for continuous data, where appropriate, with their 95% confidence intervals (CIs).

Main results

We included one new study (338 participants/catheters) in this update, which brought the total included to 57 studies with 16,784 catheters and 11 types of impregnations. The total number of participants enrolled was unclear, as some studies did not provide this information. Most studies enrolled participants from the age of 18, including patients in intensive care units (ICU), oncology units and patients receiving long-term total parenteral nutrition. There were low or unclear risks of bias in the included studies, except for blinding, which was impossible in most studies due to the catheters that were being assessed having different appearances. Overall, catheter impregnation significantly reduced catheter-related blood stream infection (CRBSI), with an ARR of 2% (95% CI 3% to 1%), RR of 0.62 (95% CI 0.52 to 0.74) and NNTB of 50 (high-quality evidence). Catheter impregnation also reduced catheter colonization, with an ARR of 9% (95% CI 12% to 7%), RR of 0.67 (95% CI 0.59 to 0.76) and NNTB of 11 (moderate-quality evidence, downgraded due to substantial heterogeneity). However, catheter impregnation made no significant difference to the rates of clinically diagnosed sepsis (RR 1.0, 95% CI 0.88 to 1.13; moderate-quality evidence, downgraded due to a suspicion of publication bias), all-cause mortality (RR 0.92, 95% CI 0.80 to 1.07; high-quality evidence) and catheter-related local infections (RR 0.84, 95% CI 0.66 to 1.07; 2688 catheters, moderate quality evidence, downgraded due to wide 95% CI).

In our subgroup analyses, we found that the magnitudes of benefits for impregnated CVCs varied between studies that enrolled different types of participants. For the outcome of catheter colonization, catheter impregnation conferred significant benefit in studies conducted in ICUs (RR 0.70; 95% CI 0.61 to 0.80) but not in studies conducted in haematological and oncological units (RR 0.75; 95% CI 0.51 to 1.11) or studies that assessed predominantly patients who required CVCs for long-term total parenteral nutrition (RR 0.99; 95% CI 0.74 to 1.34). However, there was no such variation for the outcome of CRBSI. The magnitude of the effects was also not affected by the participants' baseline risks.

There were no significant differences between the impregnated and non-impregnated groups in the rates of adverse effects, including thrombosis/thrombophlebitis, bleeding, erythema and/or tenderness at the insertion site.

Authors' conclusions

This review confirms the effectiveness of antimicrobial CVCs in reducing rates of CRBSI and catheter colonization. However, the magnitude of benefits regarding catheter colonization varied according to setting, with significant benefits only in studies conducted in ICUs. A comparatively smaller body of evidence suggests that antimicrobial CVCs do not appear to reduce clinically diagnosed sepsis or mortality significantly. Our findings call for caution in routinely recommending the use of antimicrobial-impregnated CVCs across all settings. Further randomized controlled trials assessing antimicrobial CVCs should include important clinical outcomes like the overall rates of sepsis and mortality.

PLAIN LANGUAGE SUMMARY

Central venous catheter coating with antiseptics or antibiotics for reducing catheter-related infections in adults

Background

CVCs are essential devices for giving fluids, medications, intravenous nutrition and cancer treatment to patients. Compared to peripheral catheters (i.e. tubes inserted via veins in the limbs that are designed for short-term use), CVCs are longer and reach deeper into the major veins of the body, providing a more secure and durable intravenous access. However, infections, especially of the bloodstream, are common in patients with CVCs. Sometimes these infections are fatal. Several measures have been developed to reduce such infections, including coating or impregnation of CVCs with antiseptics or antibiotics. While these new technologies are promising, it is not clear whether they provide effective protection for a sufficiently long period against the wide variety of bacteria that might adapt to any strategy designed to overcome them. Furthermore, the benefits of these modified catheters in different settings, e.g. intensive care units (ICU), standard wards and cancer units, also require on-going evaluation. Many clinical guidelines recommend the use of antimicrobial-impregnated CVCs, although studies reveal conflicting results

Review question

We reviewed evidence about the effectiveness and safety of antimicrobial-impregnated central venous catheters (CVCs) on bloodstream infections and death in adults who needed a CVC, and found 57 relevant studies.

Search date

In this update, we included evidence current to March 2015, updating the previous version of the review which was current to March 2012.

Study characteristics

We included 57 studies with 16,784 catheters and 11 types of antimicrobial impregnation. The total number of participants was not clear as some studies did not provide this information, and some participants may have had more than one CVC in the course of their treatment. The participants were mostly adults aged 18 and over in ICUs, cancer units or other healthcare settings in which CVCs were used for intravenous treatment or nutrition. All studies were completed when the participants left the unit or hospital, and no study followed up participants in the long-term.

Source of funding

Twenty-six out of 57 studies were funded fully or partially by the catheter manufacturers or distributors, two studies were government-funded, and two received no funding. Funding sources were not stated in the remaining 27 studies.

Key results

Compared to those participants given non-impregnated catheters, participants with impregnated catheters had 2% lower rates of bloodstream infections that were definitely catheter-related (CRBSI) (average absolute reduction in CRBSI: 2%). There was also a 9% lower chance of finding bacteria on these impregnated catheters (catheter colonization) (average absolute reduction in catheter colonization: 9%). However, the benefits of these catheters in reducing catheter colonization varied according to study setting, with significant benefits observed only in studies conducted in the ICUs. There were no clinically significant differences in the overall rates of bloodstream infections (clinically-diagnosed sepsis) or in death, although these outcomes were assessed in fewer studies than CRBSI and catheter colonization. Impregnated catheters appeared no more likely than non-impregnated catheters to cause adverse effects such as bleeding, clots, pain or redness at the insertion site.

Quality of evidence

The amount of information in this review contributed to high-quality evidence for the major outcomes of CRBSI, all-cause mortality and adverse effects. However, for clinically-diagnosed sepsis we considered the quality of the evidence to be moderate, as we suspected that there had been selective non-publication of certain trials. We considered the quality of evidence to be moderate for catheter colonization too, due to major inconsistencies in the direction of the results amongst the included studies.

Authors' conclusion

While impregnated catheters are effective in reducing CRBSI and catheter colonization, particularly in ICUs, they may not be effective across all settings. Furthermore, our review shows that these impregnated catheters do not appear to reduce all bloodstream infections and numbers of deaths. The discrepancy between the findings for CRBSI, catheter colonization and overall bloodstream infections might be related to the limitations of the catheter and blood cultures that were used in most studies for detecting catheter-related infections. Future research should include overall bloodstream infections and death as key outcomes, and include some advanced methods for detecting micro-organisms on the catheters and in the bloodstream to evaluate the presence of catheter-related infections more accurately.